ORIGINAL

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	
2000 Biennial Regulatory Review --	)	
Streamlining and Other Revisions of Part 25 of	)	IB Docket No. 00-248
the Commission's Rules Governing the	)	
Licensing of, and Spectrum Usage by, Satellite	)	
Network Earth Stations and Space Stations	)	
	)	

COMMENTS OF ALOHA NETWORKS, INC.

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Aloha Networks, Inc. ("Aloha Networks") hereby files its comments in response to the December 14, 2000 *Notice of Proposed Rulemaking* in the above-captioned proceeding. *Notice of Proposed Rulemaking*, FCC 00-435 (December 14, 2000) (the "*Notice*").

I. Introduction

Aloha Networks' comments are limited to the VSAT licensing issues discussed in Section V of the *Notice*. In particular, Aloha Networks addresses the proposed revision of 47 C.F.R. § 25.134(a), which governs maximum transmitter power for Ku band VSAT earth station antennas.[1] The comments address the issue of ensuring that simultaneous transmissions from multiple VSAT transmitters utilizing random access channels – commonly referred to as ALOHA channels – do not cause unacceptable levels of interference to neighboring satellites.

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[1] As discussed below, the comments of Aloha Networks apply equally to the proposed addition to 47 C.F.R. § 25.212, which addresses analogous issues with respect to C band VSATs.

II. Statement of Interest

Aloha Networks is a VSAT network equipment supplier based in San Francisco. Aloha Networks has received almost $4 Million in grants from the Department of Defense Advanced Research Projects Agency, the National Science Foundation, and other government agencies to develop and to commercialize advanced versions of the classical ALOHA access protocol. Aloha Networks' first product, SkyDSL, uses an advanced spread spectrum version of an ALOHA protocol, called Spread ALOHA. SkyDSL provides high speed, reliable, and affordable access to the Internet for small and medium enterprises by means of submeter antennas using Spread ALOHA.

Aloha Networks' interest and expertise in VSAT issues extends far beyond its current business affairs. Aloha Networks' founder and Chief Technical Officer, Dr. Norman Abramson, developed the original ALOHA Protocol at the University of Hawaii in the 1970s. Dr. Abramson has taught communications theory courses as a member of the faculty at the University of Hawaii, Stanford University, the University of California at Berkley, Harvard University and MIT. At the University of Hawaii, Dr. Abramson was director of the ALOHANET, which has been called the first modern data network. Dr. Abramson has lectured extensively on the ALOHA Protocol and its variants at university and industrial laboratories throughout the world. He has published 16 technical papers on ALOHA channels, and in 1993 he edited *Multiple Access Communications*, a book published by the Institute of Electrical and Electronics Engineers ("IEEE") Press that focused on various forms of network access, including Frequency Division Multiple Access ("FDMA"), Time Division Multiple Access ("TDMA"), Code Division Multiple Access ("CDMA"), ALOHA and Spread ALOHA. In 1995, Dr. Abramson received the 1995 Koji Kobayashi Computers and Communications Award from the IEEE which recognized that Dr. Abramson's development of the ALOHA Protocol laid the foundation for the development of modern local area networks. In 1998, Dr. Abramson received the IEEE Information Theory Society Golden Jubilee Award for his work on ALOHA channels, and in 2000 he received the Eduard Rhein Foundation Award in Munich for his work on ALOHA and Spread ALOHA multiple access. Dr. Abramson is responsible for the technical content of the instant comments.

III. Background on Comments

A. Spacenet's Petition

The fundamental issue addressed in Section V of the *Notice* concerns the application of Section 25.134(a)'s maximum power limits to networks of multiple VSAT transmitters using random access protocols. That issue was first raised in a petition filed by Spacenet, Inc. ("Spacenet") for a declaratory ruling or, in the alternative, rulemaking.[2] Briefly stated, the problem is that, even if each transmitter in the VSAT network meets the power limitations of Section 25.134(a), the total transmitted power in a given frequency band can exceed that limit when two or more earth stations transmit simultaneously. In those situations where the power limit is exceeded, interference can be caused to adjacent satellites.

When Section 25.134 was first promulgated in 1991, the probability – and adverse consequences – of adjacent satellite interference were extremely minimal. However, times have changed. As explained in the *Notice*, there has been a tremendous growth in the use of VSATs in recent years, and that growth is likely to explode in the near future as more and more parties turn to VSATs for Internet access and other communications needs. Spacenet therefore sought a ruling that random access schemes that result in infrequent "collisions" among transmissions do not violate Section 25.134(a) if the collision is very brief. To that end, Spacenet proposed that the VSAT operation would be acceptable if it satisfied the following parameters:

> (i) each remote station individually satisfies the antenna input power density limit of Section 25.134(a);
>
> (ii) the probability of k stations transmitting, for k greater than 1, is below the limit defined by $P[k] = 0.38 / k! \times e(-0.38)$; and
>
> (iii) the maximum duration of any individual collision is less than 100 milliseconds.

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[2] Petition of Spacenet Inc. for Declaratory Ruling that Section 25.134 of the Commission's Rules Permits VSAT Remote Stations in the Fixed Satellite Service to Use Network Access Schemes that Allow Statistically Infrequent Overlapping Transmissions of Short Duration or, in the Alternative, for Rulemaking to Amend that Section, RM-9864 (August 5, 2000) (the "Spacenet Petition").

Petition of Spacenet, DA 00-2664 (IB December 7, 2000) ("*Spacenet Order*") at ¶ 7.

Aloha Networks filed comments on the Spacenet Petition. More specifically, Aloha Networks raised questions whether the probability formula for collisions contained in clause (ii) of Spacenet's proposal accurately captured the level of probability of collisions where a group of low-power antennas collectively exceed the power limitations of Section 25.135(a). In its comments on the Spacenet Petition, Hughes Network Systems ("Hughes") similarly objected to the Spacenet proposal in part because "it focuses on system-specific design parameters."[3]

The International Bureau denied Spacenet's request for a declaratory ruling in the *Spacenet Order*. The staff concluded that issuance of a declaratory ruling would be inappropriate because the consequence of collisions could be more significant than anticipated or described by Spacenet. For that reason, the staff determined that it would be more appropriate to issue a rulemaking in which these and other related issues could be explored. *Spacenet Order* at ¶ 9.

B. The *Notice*

Section V of the *Notice* addresses the issues raised by the Spacenet Petition. The Commission recognized that satellite interference could be caused by multiple antenna "transmitting to the same space station, in the same frequency band, at the same time, at the maximum power level specified in our two-degree spacing rules" in the same network. *Notice*, App. E at 80. The Commission expressed the goal of crafting a rule "to prevent these simultaneous transmissions from causing unacceptable interference to adjacent satellites in a two-degree-spacing environment." *Id.*

Rather than seek comment on the Spacenet proposal, the Commission proposed its own revision to Sections 25.134(a).[4] While Aloha Networks applauds the Commission for its attempt to address the problem identified by the Spacenet Petition, there are some serious flaws with the

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[3] Comments of Hughes Network Systems (May 30, 2000) at p. 3.

[4] The Commission also proposed an analogous revision to Section 25.212(d), which governs transmitter power restrictions for C band VSAT transmitters. The instant comments apply equally to the Commission's proposed revisions to both rules.

Commission's approach. Those flaws -- and a proposed revision to the Commission's approach which corrects those flaws -- are discussed below.

IV. Discussion

A. Flaws in the Commission's Proposed Revisions to Section 25.134(a)

The Commission's proposed revisions to Section 25.134(a) attempt to classify VSAT networks in one of four specific classes based on the multiple access technique utilized by the network: (1) FDMA and TDMA, (2) CDMA, (3) Aloha multiple access technique, and (4) "CDMA/Aloha."[5] The purpose of the foregoing classifications is to prescribe the maximum transmitter power spectral density for each of the four techniques. To that end, the Commission proposed to amend Sections 25.134(a) and 25.212(d) to include the following language: "the initial maximum transmitter power spectral density of a digital modulated carrier into any GSO FSS earth station antenna shall not exceed $-14.0 - 10\log(N)$ dB(W/4 kHz)." *Notice* at ¶ 55. The Commission explained that the rule would specify different values for "*N*" for systems using each of the four defined classes. *Id.*

There are two primary problems with the foregoing approach. First, the Commission's proposed classification fails to identify all existing and prospective multiple access techniques. Second, the use of the Commission's formula to determine the probability of collisions will not in fact provide the regulatory or practical comfort which the Commission seeks in its revised rule.

1. Classification of VSAT Networks

Contrary to the assumption in the *Notice*, multiple access techniques utilized by VSAT networks cannot be pigeonholed into four categories of multiple access techniques. Quite the contrary. There are any number of multiple access techniques which involve some combination of one or more of the multiple access techniques identified in the *Notice*. For example, many operating VSAT networks employ an access technique which can be described as a combination of FDMA and classical Aloha.

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[5] It appears that the fourth class is meant to include the technique more commonly referred to as spread spectrum ALOHA, which is commonly referred to as "Spread Aloha" or "SAMA."

Indeed, the Spacenet system (as described in its Petition) appears to be a system employing a random frequency hopping FDMA structure superimposed on a slotted Aloha random access architecture.

Other combinations of FDMA, TDMA, CDMA and Aloha are limited only by the imagination of the system designer. The literature dealing with multiple access techniques reflects the considerable variations in actual and potential systems. The protocols include hybrids such as PRMA (Rutgers), STRMA (Berkeley), AA/TDMA (NEC), and PCMA (ViaSat). A wide variety of other combination access techniques are also available. An apt example is CSMA, CSMA/CD, which has been used for multiple access in terrestrial networks and may some day find an application in certain specialized VSAT networks.

The *Notice's* use of four multiple access techniques also fails to account for frequency hopping multiple access systems. Although such systems have found application only in military networks to date, a commercial network using spread spectrum frequency hopping could be designed. Use of frequency hopping only compounds the difficulty in trying to allocate multiple access techniques to one of only four categories.

The flaws with the *Notice's* classification scheme are compounded by the failure to anticipate the possibility -- indeed, near certainty -- that new multiple access techniques will be developed. Trying to fashion a rule which anticipates the nature, scope and number of those new multiple access techniques is daunting. One result is almost certain. As new techniques are developed, the Commission will be forced to constantly revise its rules in a near impossible effort to maintain pace with technological advancement. And, as it attempts to do so, the Commission will have to make a series of judgments to make its rule compatible with each new technology. Even if it succeeds in that endeavor, the Commission would still be unable to provide licensees with the prior notice of what will or will not be acceptable as they develop their multiple access networks.

In short, a classification scheme confined to four neat categories of multiple access techniques has the same system-specific problems that Hughes identified with respect to the Spacenet

proposal. That kind of scheme will mire the Commission in a never-ending series of revisions and waiver requests that will defeat the purpose of the *Notice* to generate a bright-line rule which accounts for the anticipated and explosive use of satellite communications for Internet access and other communications needs.

2. Formula for the Probability of Collisions

Even if it were possible to assign VSAT networks to one of the Commission's four proposed categories, there is still a problem in relying on the parameter N to define the probability of collision (and thus the threshold at which collisions cause interference to adjacent satellites). The *Notice* defines N (for the proposed class 2 and class 4 systems) as "the likely maximum number of co-frequency simultaneously transmitting earth stations in the same satellite receiving beam." *Notice,* Appendix B at 53. However, the likely maximum number of transmitting earth stations cannot be a well defined quantity when, as here, the number of earth stations transmitting is variable. Indeed, in order to specify the maximum transmitter power spectral density, the central question which must be answered is how low the probability of interference must be before the potential interference to adjacent satellites can be deemed negligible.

A specific example can illustrate the practical parameters of that question. In a slotted ALOHA channel shared by 100 earth stations, the maximum number of earth stations which can attempt to transmit simultaneously is 100. Such a situation will almost always cause interference to an adjacent satellite. However, in a slotted ALOHA channel operating at peak throughput, the probability of such an event (lasting a few tens of milliseconds) occurs with a probability equal to 10^{-200}, or less than once every 10^{190} years. Of course, the event consisting of only ten earth stations transmitting simultaneously will occur on a less cosmic time scale. Thus, the use of the term "likely maximum number" in Sections 25.134(a) and 25.212(d) requires a quantifiable definition if it is to have any meaning.

In the revision to Section 25.134(a) proposed in the *Notice*, the parameter N is defined as being equal to two for VSAT networks using Aloha multiple access. Such a definition is equivalent to a determination that the probability of more than two earth stations simultaneously transmitting in the same

satellite receiving beam is so low as to be negligible. As explained in Appendix E of the *Notice*, that view is based upon the assumption of a 38% channel load. Although the channel load figure of 38% is a reasonable operating point for a slotted ALOHA channel operating without a collision resolution algorithm, the proposed rules do not limit system operators to that channel load. Thus, a VSAT network operating under the proposed rules could operate at a higher channel load. In fact, the maximum throughput of a slotted ALOHA channel is achieved at a channel load of 100% with a corresponding throughput equal to 37%. At this level in a slotted ALOHA channel shared by 100 earth stations, the probability of more than two earth stations simultaneously transmitting in the same satellite receiving beam is about 8%.

The foregoing example (as well as other easily conceived circumstances) demonstrate that the Commission's proposed formula for probability does not cure the defect in the Spacenet proposal and will not safeguard satellites from "simultaneous transmissions . . . causing unacceptable interference to adjacent satellites in a two-degree-spacing environment." *Notice,* App. E at 80.

B. Aloha Networks' Proposal

The revisions to Commission rules should provide a probability of interference which takes into account the broad variety of multiple access techniques and the need for certainty. To achieve those goals, Aloha Networks proposes the following revision to Section 25.134(a):[6]

> (a) All applications for VSAT service in the 12/14 GHz band that meet the following requirements will be routinely processed:
>
> (1) the operation of each antenna within the network satisfies the following parameters:
>
> (i) each remote station individually satisfies the antenna input power density limit of subsection (a) of Section 25.134;
>
> (ii) the maximum transmitter power spectral density of a digital modulated carrier into any GSO FSS earth station antenna shall not exceed -14.0 – 10 log (N) db (W/4 kHz) where N is the smallest number of co-frequency simultaneously transmitting earth stations in the same satellite receiving beam such that the

[6] A similar revision is suggested for section 25.212(d).

probability of an event with greater than N simultaneous transmitters is less than .001; and

(iii) the maximum duration of any individual collision is less than 100 milliseconds.

* * *

Clauses (i) and (iii) above are identical to the same numbered clauses proposed in the Spacenet Petition. Clause (ii) is an attempt to address the issue introduced by clause (ii) of the Spacenet proposal using the terms defined in the Commission's *Notice*. Unlike clause (ii) of the Spacenet proposal, clause (ii) in Aloha Networks' proposal is not system-specific. Instead, of a system specific clause, the revised clause proposed by Aloha Networks focuses on the objective of the proposed rules -- to prevent unacceptable interference in adjacent satellites regardless of the multiple access technique being used. By focusing on the objective of controlling the radiated power from all transmitters in the definition of N, Aloha Networks' approach allows the Commission to bypass the problem of the classification of VSAT networks discussed above. Thus, the rule can apply to any existing system without the need to categorize that system in any way and will apply equally well to new systems which may be proposed in the future.[7]

Unlike the qualitative, non-numerical definition of N proposed in the *Notice*, the value of N is keyed to the specification of the probability of exceeding N simultaneous transmitters. Aloha Networks suggests 0.001for that probability, but another value for that probability could be chosen to provide more (or less) protection from interference to adjacent satellites.[8]

To understand the benefits of Aloha Networks' proposal, consider a situation in which *Pmax* is defined as the maximum power allowed by Section 25.134(a) for a transmitter in a network with a single transmitting VSAT. Under the newly-proposed clause (ii), the total power radiated by all the simultaneous transmitters in the a network could not exceed *Pmax* more than 0.1% of the time. Stated

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[7] It should be noted, for example, that for orthogonal forms of multiple access such as FDMA and TDMA, the value of N is equal to one as is the case in the rule changes proposed in the *Notice*.

[8] The value suggested in the Aloha Networks proposal was chosen as a compromise between the value of 0.01 suggested in Appendix E, 3E of the Notice and the value of 0.0001 used by the European Telecommunications Standards Institute (ETSI) in a similar context. Technical Basis for Regulation (TBR 28), European Telecommunications Standards Institute (December, 1997), at 15.

another way, in that network, the total radiation from all transmitters could exceed *Pmax* for no more than 3.6 seconds in a busy hour. If the Commission were to use the value of 0.01 suggested in Appendix E of the *Notice,* the total radiation from all transmitters could exceed *Pmax* for no more than 36 seconds in a busy hour; if the value of 0.0001 used by the ETSI were used, the total radiation from all transmitters could exceed P_0 for no more than 0.36 seconds in a busy hour.

V. Conclusion

WHEREFORE, in view of the foregoing, it is respectfully requested that the Commission adopt the changes proposed by Aloha Networks for Sections 25.134(a) and 25.212(d) of the rules.

Respectfully submitted,

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